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厦门大学

硕 士 学 位 论 文

寰椎椎弓根螺钉内固定技术的基础研究

The basic research of the atlas pedicle screw fixation

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摘 要

上颈椎疾患在临床上较为常见，创伤、肿瘤、感染、先天性畸形、退变性疾病以及自身免疫性疾病等均可导致，上颈椎疾患的手术治疗较为复杂，难度高、风险大，严重者伤及颈脊髓、血管，甚至危及生命。对颈椎伤病的外科治疗，目的可归结为:恢复颈椎的解剖序列;神经根或脊髓减压;重建颈椎稳定性。颈椎内固定是实现这些目的的有效手段。在颈椎的单种内固定方法中，经椎弓根内固定有生物力学稳定性最强，融合率高，术后无需外固定，便于护理和病人生活等优点。由于上颈椎椎弓根特殊的解剖和毗邻，曾认为上颈椎经椎弓根固定技术的难度和危险很大。但近年来的相关研究和临床应用表明，上颈椎经椎弓根螺钉固定安全性仍较高，具有良好的发展前景。为了更好的使该技术应用于临床，减少手术并发症，我们进行了以下方面的探索。

第一部分：解剖学研究

寰椎椎弓根螺钉内固定通道的解剖学基础研究

目的 利用三维影像学探讨正常人寰椎椎弓根螺钉内固定通道的解剖学基础。

方法 从我院PACS系统中随机选取60例头颈部CTA枕寰枢复合体无明确异常的图像资料，进行回顾性三维CT成像。测量相关解剖学数据，以颈椎扩孔器横截面面积（3～5mm^2）为对照，归纳出3种椎弓根类型。

结果 60例头颈部CTA三维图像显示寰椎及周围结构清楚，测量出寰椎椎动脉沟底部后弓外径高度男性4.39±1.16mm，女性3.84±0.84mm，小于常规螺钉直径（3.50mm）占27.7%；在寰椎椎弓根通道分型中，I型68侧，占57%，II型25侧，占21%；III型27侧，占23%；皮质骨面积比例随通道面积的减小而增大，在各型椎弓根通道都在80%以上。

结论 寰椎椎动脉沟底部后弓外径高度是制约寰椎椎弓根螺钉固定的重要因素，而寰椎椎弓根骨性通道的解剖结构特点则影响置钉技术的选择；设计出适应寰椎椎动脉沟底部后弓外径高度的螺钉是非常必要的。

第二部分：生物力学研究

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新型寰椎内径锥形螺钉的可行性研究

目的 比较两种设计的寰椎椎弓根螺钉的最大拔出力，为临床选择寰椎椎弓根螺钉类型提供生物力学依据。

方法 设计制作两种寰椎椎弓根螺钉，根据螺纹部分分为皮质骨螺钉(A 型螺钉)、内径锥形螺钉(B 型螺钉)，利用 24 节新鲜猪寰椎标本，置入两种类型的椎弓根螺钉，进行拔出试验，测定每种螺钉的最大拔出力，进行统计学分析比较。

结果 同一长度，不同设计的螺钉抗拔出力接近，均无显著性差异($p<0.01$)；同一直径，28mm 比 26mm 的抗拔出力略大，但均无显著性差异($p<0.01$)。

结论 新型寰椎内径锥形螺钉（3.0mm）抗拔力高，螺钉根部强度好，抗弯曲、断裂性能好，可提供足够的即刻稳定性，是寰椎椎弓根固定的理想螺钉类型。

第三部分：影像学研究

枕寰枢复合体后方静脉结构三维 CT 解剖学研究

目的 观察枕寰枢复合体后方静脉丛结构的解剖特点，为上颈椎后方手术入路提供解剖依据。

方法 从我院 PACS 系统中随机筛选 60 例头颈部 CTA 枕寰枢复合体无明确异常资料，进行回顾性三维 CT 成像。显示及测量枕寰枢复合体后方静脉结构，描述枕寰枢复合体的空间关系。

结果 60 例头颈部 CTA 三维图像显示枕寰枢复合体及静脉结构清楚，测量出枕下海绵窦体积左侧 3.15±1.13mm³，右侧 2.85 ±1.26mm³，硬膜外静脉丛体积左侧 1.94±0.83mm³，右侧 1.96 ±0.63mm³，枕下海绵窦与中线距离左侧 1.73 ±0.29mm，右侧 1.73 ±0.32mm，硬膜外静脉丛与中线距离左侧 1.56±0.35mm，右侧 1.37±0.39mm。枕下海绵窦、硬膜外静脉丛体积左右侧差异均没有统计学意义（$P>0.05$）。

结论 枕寰枢复合体后方静脉、静脉丛血管丰富、结构变异多，术前三维 CT 显示其大小、形态及相互关系，为临床制定个体化手术方案提供解剖基础并保证手术安全性。

关键词：寰椎 椎弓根 内径锥形螺钉 生物力学 CT 血管造影 解剖学

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The basic research of the atlas pedicle screw fixation

Abstract

The upper cervical disease is more common in clinical practice, trauma, tumor, infection, congenital deformity, degenerative disease, and rheumatoid arthritis can lead to, surgical treatment is more complex, pillow can cause neck pain, severe cervical spinal cord injuries and even life-threatening. Surgical treatment of cervical spine injuries, the purpose can be attributed to: restore cervical anatomy series; nerve root or spinal cord decompression; reconstruction cervical stability. The goals of the spinal fixation are as follows:

To assist in correcting or preventing additional changes in spinal alignment, to enhance fusion rates, and to allow early mobilization of the patient without the need for cumbersome external immobilization. Transpedicular screw fixation, with its superior biomechanical properties, has been very popular in stabilization of thoralumbar segments. In cervical region, because of relatively small size of the cervical Pedicle and its adjacent, placement of screws into the upper cervical pedicle ever being thought to be an unacceptable risk to the vertebral artery, spinal cord, and nerve roots. However, the anatomical studies and clinical applications of this technique in recent years demonstrated the cervical transpedicular fixation still is a safe technique, and having a tendency of wide application. However, compared with comprehensive and abundant studies related to transpedicular fixation in thoralumbar region, the intensive study of this technique in upper cervical region is very limited. To improve the safety and rationality of cervical transpedicular screw fixation, the following studies were designed.

Part 1. Anatomic study

Anatomic basic study of the channel of atlas pedicle screw fixation

【abstract】 Objective: To investigate the anatomic structure of the channel of

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Atlas pedicle screw fixation by using medical imaging techniques. Methods: Randomly chose 60 atlas lesion free cases from patients, who have got a computed tomography angiography (CTA) screening due to cerebral vascular diseases, from PACS（Picture Archiving and Communication Systems）database. Three-dimension imaging analysis was used to investigate the anatomic character of the bone channel of atlas pedicle screw and collect other relative anatomic information. By taking the cross section area of reamer（3~5mm^2）as a baseline and combining the experience of the surgeon (the surgeon found that the channel of arch of atlas, in 5mm area, has lots cortical bone), three pedicle types in 60 patients have been found based on the imaging study. Type I: After the reamer enter 5mm depth into the pedicle screw channel; Kirschner wire with 1mm diameter can be smoothly inserted without difficulty; and the cancellous bone area is found more than 5mm^2. Type II: After the reamer enter 5mm depth into the pedicle screw channel; Kirschner wire with 1mm diameter can be inserted; and the cancellous bone area is about 3~5mm^2. The reamer need to be inserted into the whole pedicle channel. Type III: After the reamer enter 5mm depth into the pedicle screw channel, Kirschner wire with 1mm diameter can be hardly inserted; and the cancellous bone area is less than 3mm^2; The surgeons need to use the reamer to create pedicle screw channel based on their own experience. Results：The diameter of the Atlas posterior arch of the vertebral artery groove bottom in male is 4.39±1.16mm, while in female is 3.84±0.84mm. The ratio of the atlas posterior arch of the vertebral artery groove bottom with a diameter less than that of normal screw (3.50mm) is 27.7% in the whole cases studies. In the arch of the atlas channel types, I type has 68 cases (57%); II type 25 has cases (21%); III type has 27 cases (23%). The cortical bone area has a more than 80% ratio in all types of pedicle channel, which is increasing as the atlas pedicle channel cross-sectional area decreased. Conclusions：The use of imaging technology in the preoperative evaluation of atlas pedicle channel is feasible. It helps to group the atlas pedicle channel, which benefits the surgery in a certain level. The diameter of atlas posterior arch of the vertebral artery groove bottom is an important factor which needs to be considered for the atlas pedicle screw fixation. In addition, the antonymic structure of the atlas bone

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of the pedicle anatomy of channel can affect the choices of the pedicle screw techniques. The design of the screw to meet the biomechanical criteria and to adapt the diameter of the bottom of the atlas posterior arch of the vertebral artery groove is undoubtedly necessary.

Part 2. Biomechanics study

Feasibility study of the new atlas diameter tapered screw

【Abstract】 Objective: Compare the greatest pullout strength of two designed atlas pedicle screws, to provide biomechanical basis for clinical choosing the types of atlas pedicle screws. Method: Designed two kinds of atlas pedicle screws, according to the threaded part, classified into the threaded portion (A-type screws) and screw diameter cone (B-type screw). Using 24 samples of fresh pig atlas, put into these two types of pedicle screws, then measure the maximum pullout strength for each screw, results to be analyzed and compared by statistical method. Result: In the condition of same diameter, the pull out strength of 28mm is slightly larger than 26mm, but there was no significant difference ($P<0.01$). In the condition of same length, the pull out strength of different types of screws is nearly the same, there was no significant difference ($P<0.01$).Conclusion: The new atlas diameter tapered screw (3.0mm) which has high pulling force, the screw root strength and resistance to bending and fracture, can provide sufficient immediate stability. So it is the ideal type of atlas pedicle screw.

Part 3. Imageology study

CTA anatomic study of the vein structure behind the atlantoaxial complex

【Abstract】 Objective: Observe the complex venous plexus structure behind the craniocervical junction, to provide anatomical data for the surgery. Method: Select 60 examples of normal CTA craniocervical junction at random to make the retrospective computed tomography angiography (CTA). The purpose is to show and measure the venous plexus beside craniocervical junction, and describe the spatial relationship of craniocervical junction. Result: The CTA three-dimensional graphics engine shows that the structure of 60 samples of craniocervical junction is clear, and measure the volume of suboccipital cavernous sinus is 3.15±1.13mm³ in the left, 2.85 ±1.26mm³

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in the right. The volume of epidural venous plexus is 1.94±0.83mm³ in the left, 1.96 ±0.63mm³ in the right. The distance between suboccipital cavernous sinus and center line is 1.73±0.29mm in the left, 1.73 ±0.32mm in the right. The distance between epidural venous plexus and center line is 1.56±0.35mm in the left, 1.37±0.39mm in the right. The difference between the left side and right side of suboccipital cavernous sinus and epidural venous plexus has no meaning for statistical significance(P>0.05). Conclusion: The structure of venous plexus beside craniocervical junction is very complex. The three-dimension CT of the size, form and relationship before operation, which provides anatomical basis and safety for making the individual plan of operation.

Keywords: atlas; pedicle; diameter tapered screw; biomechanics; CTA; anatomy

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